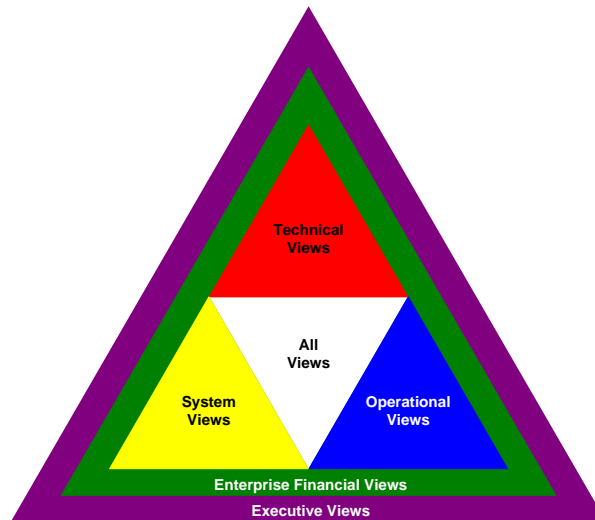# Federal Aviation Administration
National Airspace System Enterprise Architecture
(NAS EA)

Office of NextGen (ANG)

Far-Term Systems/Services Functionality Description (SV-4)

Version 3.0

Part of Integrated Far-Term Release Package 2.0

20 December 2012

Version History

Version	Date	Description of Change
Baseline	31 October 2009	Approved by EAB
Revision A Draft Version 1	30 December 2010	Initial Review
Revision A Draft Version 2	28 January 2011	Initial Review
Revision A Draft Version 3	22 February 2011	Initial Review
Integrated Release Package 1.0 Draft V 2.0	30 September 2011	draft version 2.0 document release
Integrated Release Package 1.0 Draft V 2.1	15 February 2012	Updated to include SV-4 data flow diagrams.
Integrated Far-Term Release Package 1.1 Review Draft SV-4 v2.2	28 September 2012	Updated Layered Diagram and functional hierarchy based on feedback from Tech Center.
Integrated Far-Term Release Package 1.2 Final Draft SV-4 v2.3	02 November 2012	Updated sub-functions for Navigation Support, Surveillance Data Collection, and Weather Data Collection.
Integrated Far-Term Release Package 2.0 Baseline SV-4 v3.0	20 December 2012	Approved by JRC

Document Purpose

This document presents the FAA Far-Term NAS Systems/Services Functionality Description (SV-4) and information related to its use, value, development methodology, and next steps. This is a standalone document enabling the reader to understand, appraise, and use the Far-Term SV-4 as presented in the following sections. This architectural product is also part of an Integrated Far-Term Release Package 2.0 and represents one of many viewpoints of the Far-Term NAS EA.

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Far-Term Systems/Services Functionality Description (SV-4)

1 Introduction

The purpose of the National Airspace System (NAS) Enterprise Architecture (EA) development initiative is to produce relative data and information through architecture products that provide critical insights and transformational change over several timeframes (As-Is, Mid-Term, and Far-Term), as well as provide context and foundation from which evolution of the NAS can be explicitly understood, planned for, and realized. The NAS EA continues to mature into a comprehensive, multi-year, strategic business reference model and framework for improving, and evolving the NAS from the current portfolio of fielded systems through 2025 and beyond. The structure and discipline of ongoing NAS EA development and analysis efforts provide data and information for NAS leaders to use in order to make informed and defendable decisions that support the vision of the Next Generation Air Transportation System (NextGen).

The NAS EA is currently composed of 31 products that collectively represent the As-Is, Mid-Term, and Far-Term (desired) "architecture descriptions" that describe the operations, enabling functions, and systems and services of the NAS and their relationships. The 31 products span four major perspectives (or views) that logically combine to describe the current and desired state, i.e., the All View (AV), Operational Views (OV), Systems/Services View (SV) and the Technical Standards View (TV). Each of the OV, SV, and TV depicts certain architecture attributes; some attributes bridge two or more views and provide integrity, coherence and consistency to the architecture. Additionally, one or more architecture products comprise a view.

Each timeframe (As-Is, Mid-Term, and Far-Term) is defined to be an integrated architecture when products and their constituent architecture data elements are developed such that elements defined in one view are the same (e.g., name, definition, values) as elements referenced in another view. The term "integrated architecture" refers to an architectural description that has integrated Operational, System/Service and Technical views. More specifically, there are common references linking the OV, SV and TV.

The integrated set of NAS EA views are an important tool to facilitate coordination between many stakeholders, to include concepts and requirements developers, planners, budgeters, systems engineers, and acquisition specialists. The architecture views clarify roles, boundaries and interfaces between NAS systems/services and influence participation in requirements generation, acquisition and resource allocation and interoperability.

This document presents the Far-Term NAS Systems/Services Functionality Description (SV-4) and information related to its use, value, development methodology and associated next steps. While this document is a standalone product enabling the reader to understand, appraise, and use the Far-Term SV-4, the Far-Term Overview and Summary Information (AV-1) provides the scope and context of the Far-Term NAS EA as well as a listing of complementary products. All the architectural data elements and attributes, including terms and definitions used throughout this product and the entire NAS EA, can be found in the Far-Term Integrated Dictionary (AV-2).

2 Product Overview

This section describes the Far-Term SV-4, its value to the FAA, and anticipated uses by NAS stakeholders.

2.1 Product Description

The Far-Term Systems/Services Functionality Description (SV-4) is the enterprise-wide description of the high-level functions required to support the NAS Mission Services (e.g., Trajectory Management, Separation Management, etc.). A system/service function is defined as a process that needs to be performed to achieve a desired system/service objective (or stakeholder need) and resides within an automation system or service to transform, display (Graphical User Interface) and exchange data.

Functions are not limited to internal functions and may include Human Computer Interface (HCI) and Graphical User Interface (GUI) functions or functions that consume or produce data from/to functions that belong to external systems/services. Subsequently, the Far-Term SV-4 will:

- Define the scope of the System Views in the EA through the identification of those system/service functions that are within the "bounds" of the enterprise.
- Depict the decomposition of functions in a hierarchy to ensure the level of detailed reached is appropriate for driving requirements development.
- Inform the development of systems or services to ensure that they are performing functionality that is critical to the mission, while remaining solution independent
- Depict data exchanges that reveal the requirement or need to exchange data between system/service functions.

The Far-Term SV-4 is the Systems/Services View (SV) counterpart to the Far-Term Operational Activity Model (OV-5), which includes both a Systems/Services Functional Hierarchy Diagram and a Systems/Services Data Flow Diagram (DFD). These models depict data exchanges revealing the requirement or need to exchange data between systems or service functions. At this time, the Far-Term SV-4 consists of a layered diagram and functional hierarchy scoped to the NAS Mission Services (see Section 4 for additional description and detail).

2.2 Product Use and Value

FAA stakeholders use the NAS EA for multiple purposes, including but not limited to the development of other architectural products, as part of related improvement efforts, or in support of mission activities and decision-making. The following table details how stakeholders use the Far-Term SV-4. This is not an exhaustive list, but is representative of the utility of this product.

Table 1: Architectural stakeholders and product use

Stakeholder	Product Use
Executives, Program Managers, Planners, etc.	▪ Establishes the target vision for future NAS Mission Service and Technical Infrastructure Service functionality to inform planning and scheduling processes for operational sustainment and improvements. ▪ Supports the communication and a consistent understanding of targeted critical/transformational systemic concepts and functionality independent of how the functionality is provided.
Systems Engineers, Requirements Analysts, Architects, etc.	▪ Supports Acquisition Management System (AMS) Service Gap Analysis phase, specifically concept definition and refinement, by providing a framework to describe and analyze the systemic functionality envisioned to support future NAS Mission Services and Technical Infrastructure Services. ▪ Provides a framework to explore opportunities and close functional gaps or reduce redundancy through collaboration, standardization or consolidation. ▪ Provides a functional reference and taxonomy to further support the decomposition and modeling of Program-level systemic functionality and data flow in line with Enterprise-level products and consistently with defined program/solution requirements. ▪ Supports the analysis to identify the service categories and enterprise services that could be a causal factor for catastrophic safety hazards and security incidents should failure or degradation occur (SV-4 Layered Diagram overlays only).
Budget Analysts, Cost/Benefit Estimators, etc.	▪ With accompanying products (such as SV-5a and SV-5b), provides a framework to inform the development of expected and sustained Mission Service and Technical Infrastructure system/service functionality costs and the identification of associated benefits.

3 Product Maturity

As the NAS evolves and NextGen and Far-Term concepts are refined, the Far-Term SV-4 will reflect the changes to ensure data and information accuracy and NAS EA integrity. This version of the Far-Term SV-4 presents a functional hierarchy focusing on the Mission Services service family. Further development may include refining the existing hierarchies, developing hierarchies in other service families to paint a more complete picture of NAS functionality, and depicting how services are orchestrated together to deliver functionality associated with an operational need. This development will reveal greater levels of function detail and enable stakeholders to perform a more complete level of analysis to fit their needs.

3.1 Development Methodology

The Far-Term SV-4 is foundational to the NAS EA and has been developed following the Horizontal and Vertical Integration Strategy described in the NAS Integrated Systems Engineering Framework (ISEF) Appendix A. The Horizontal and Vertical Integration Strategy establishes a common set of architecture principles and a plan to enforce relationships and inter-dependencies between requirements and architecture elements, ensure consistency and transparency across the enterprise, and enable decision support. More specifically, horizontal integration ensures that products and their constituent data elements are developed such that architecture data elements

defined in one product are consistently used and applied within and across peer products (e.g., same definition, association, relationship and properties). Vertical integration is intended to connect or align similar Program-level architecture products and elements to their Enterprise counterpart to ensure a holistic top down/bottom up architectural representation.

The construction of the Far-Term SV-4 began with the translation of existing Context and Supplemental Diagrams from the NextGen 2025 Enterprise-Level Architecture System Interface Description (SV-1p), Revision A Draft Version 3, dated 30 December 2010. At this time, the Far-Term SV-4 functions are bounded in scope to be associated with Enterprise Services residing in the Mission Services layer (i.e., Administrative Services, Enterprise Governance, Technical Infrastructure Services, and SOA Core Services are out of scope for the Far Term SV-4). This will eliminate discussions of support and infrastructure services, leaving clarification of support and infrastructure services to nearer-term architecture efforts. Exceptions were made for Navigation Support, Surveillance Data Collection, and Weather Data Collection because they originally resided in the Mission Services layer and have since been moved into Technical Infrastructure Services.

Each Supplemental Diagram for a Mission Service contained proposed decomposition of functions, which were originally derived from the Concept of Operations (CONOPS) for the Next Generation Air Transportation System (NextGen), Version 2.0, dated 13 June 2007. The revised decomposition provided in the NextGen 2025 SV-1p was based on analysis of operational scenarios and associated activity diagrams, and on work done in support of the development of NAS requirements for 2025.

A first-order analysis of the Supplemental Diagrams showed that there were high-level bundles of data exchanges. To expose these data exchanges at their atomic levels, a second-order analysis was performed through the development of data flow diagrams (DFDs).[1] During this analysis, identifying additional data exchanges flowing between functions resulted in updating the functional hierarchy to capture information associated with the new data flows.

This iteration of the functional hierarchy is the result of up-leveling certain functions due to the original decomposition by data type (e.g., Detect Aircraft-to-Aircraft Violation, Detect Aircraft-to-Airspace Violation, Detect Aircraft-to-Weather Violation). The up-leveling streamlines the functional hierarchy by removing those repetitive functions that were decomposed by data type, and brings the focus of the SV-4 back to tasks performed by systems or services. Thus, the functional hierarchy describes the systems/services in terms of the functions that they perform with respect to the information/data that is used/consumed in the execution of those functions.

The development of the Far-Term SV-4 employed the following assumptions:

- At the enterprise-level, systems and services are described from a "black box"[2] perspective, focusing only on those system/service behaviors, inputs, and outputs that are visible to the system's/service's external environment.

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[1] While DFDs were previously developed, they have not been included in this version of the SV-4 due to the decision that further analysis and development are required (see section 3.2 Next Steps)
[2] An abstraction of a device or system in which only its externally visible behavior is considered and not its implementation or "inner workings," i.e., the device's functions, but not its components, are specified.

- A system is defined as "automation that contains functionality required to support an operational activity or procedure for a specific mission or domain. It may receive or transmit data with one or more external systems and services."[3]

- A function is defined to be "processes that need to be performed to achieve a desired system objective (or stakeholder need) and reside within an automation system to transform, display (Graphical User Interface) and exchange data."[4]

- An Enterprise Service is defined as "capabilities that are implemented using design principles that support interoperability, sharing and the reuse of functions across the enterprise. They exist as operationally oriented processes, applications, infrastructure, or any combination."[5]

- Far-Term SV-1, SV-4, and SV-5 definitions were developed simultaneously under the assumption that a highly integrated collection of systems, services, interfaces, and functions could be used to cross check for accuracy and completeness.

3.2 Next Steps

As the NAS evolves and changes over time, the functional hierarchy will continue to capture the evolving functions of NextGen. Development of the Far-Term SV-4 will evolve to include a functional palette comprising decompositions from the Mission Services and additional service families in the functional layer diagram. This will allow NextGen to hone future NAS system or service implementations with the most versatile, effective, and efficient technical solutions.

Further expansion and refinement of the functional palette will enable a first-order of analysis of NextGen capabilities, which across an integrated architecture requires a common point of reference to normalize the identification and description of system functionality. The ability to draw a capability thread associating the activity, common system function, and the systems supporting the function and capability is enabled by using common system function names and definitions. With this information, analysis can be performed to evaluate the effects of capability across a thread, and assess changes in threads when parameters and attributes are manipulated, thereby enabling horizontal and vertical assessment of capabilities depicted in other architecture products.

Further potential steps for additional Far-Term SV-4 development include:

- Determining the appropriate model notation and business rules for capturing functional data flows, while understanding the product intent and support to business needs.

- Developing functional decomposition for additional service families (Technical Infrastructure Layer) to understand full capabilities and candidate functionality supporting NextGen.

- Expanding functional palette as necessary to provide broader range of available functions; refine names and definitions with sufficient detail to provide better understanding of the purpose, inputs, outputs, and process of the function.

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[3] Air Traffic Organization, Directorate of NextGen and Operations Planning (ATO-P), *NextGen Integrated Dictionary (AV-2)*, Version 3 (May 2, 2011).
[4] Ibid.
[5] Federal Aviation Administration, *NAS Enterprise Architecture Coordination Meeting: Integration Update & Development Session*, Slide 12 (June 3, 2011).

- Determine applicability and business need to model service choreography or orchestration to describe service interactions within the enterprise.

4 Far-Term Systems/Services Functionality Description (SV-4)

This section of the document presents the Far-Term Systems/Service Functionality Description (SV-4), composed of a layered diagram and hierarchy model.

4.1 Far-Term SV-4 Layered Diagram

A key element of NextGen is the migration to net-centric operations for the NAS. For the purpose of defining a Functionality Description for a Service Oriented NAS EA, the key priorities are to identify NAS functions, describe functions as services, and layer the functions to show abstraction of service types. The abstraction of layers is roughly analogous to Open Systems Interconnection (OSI) Layered Communication Model[6] where the lowest layers correspond to physical or "on the wire" services and the upper layers indicate the decoupling between service types. Cross cutting Administrative and Governance services are shown vertically to indicate support to all the layers.

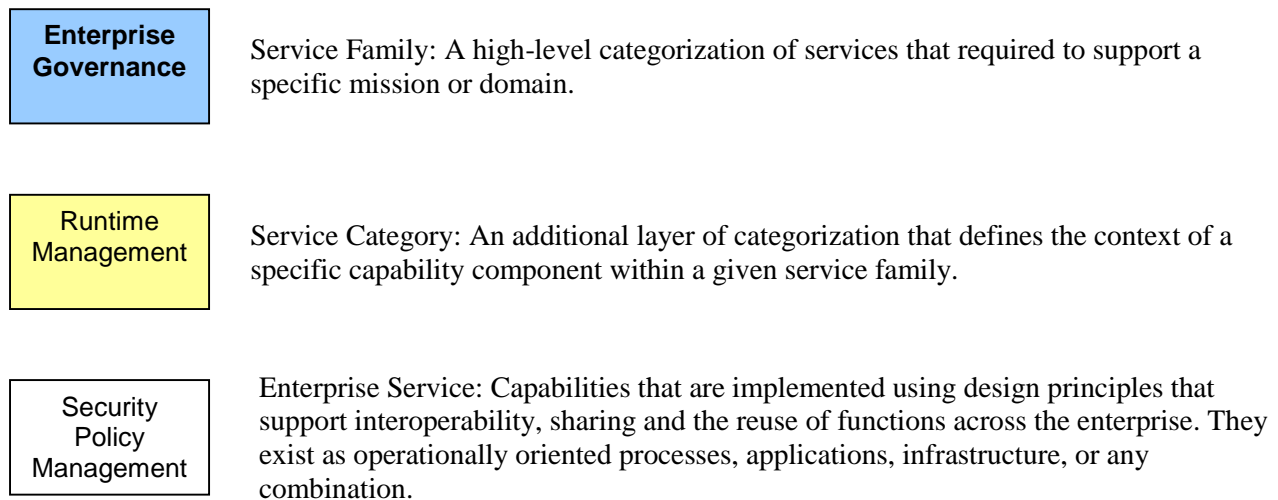The following color scheme identifies the levels of decomposition in the Far-Term SV-4 Layered Diagram:

| Enterprise Governance | Service Family: A high-level categorization of services that required to support a specific mission or domain. |

| Runtime Management | Service Category: An additional layer of categorization that defines the context of a specific capability component within a given service family. |

| Security Policy Management | Enterprise Service: Capabilities that are implemented using design principles that support interoperability, sharing and the reuse of functions across the enterprise. They exist as operationally oriented processes, applications, infrastructure, or any combination. |

Figure 1: Far-Term SV-4 Layered Diagram Legend

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[6] ITU-T Recommendation X.200: Data Networks and Open System Communications, Open Systems Interconnection – Model and Notation
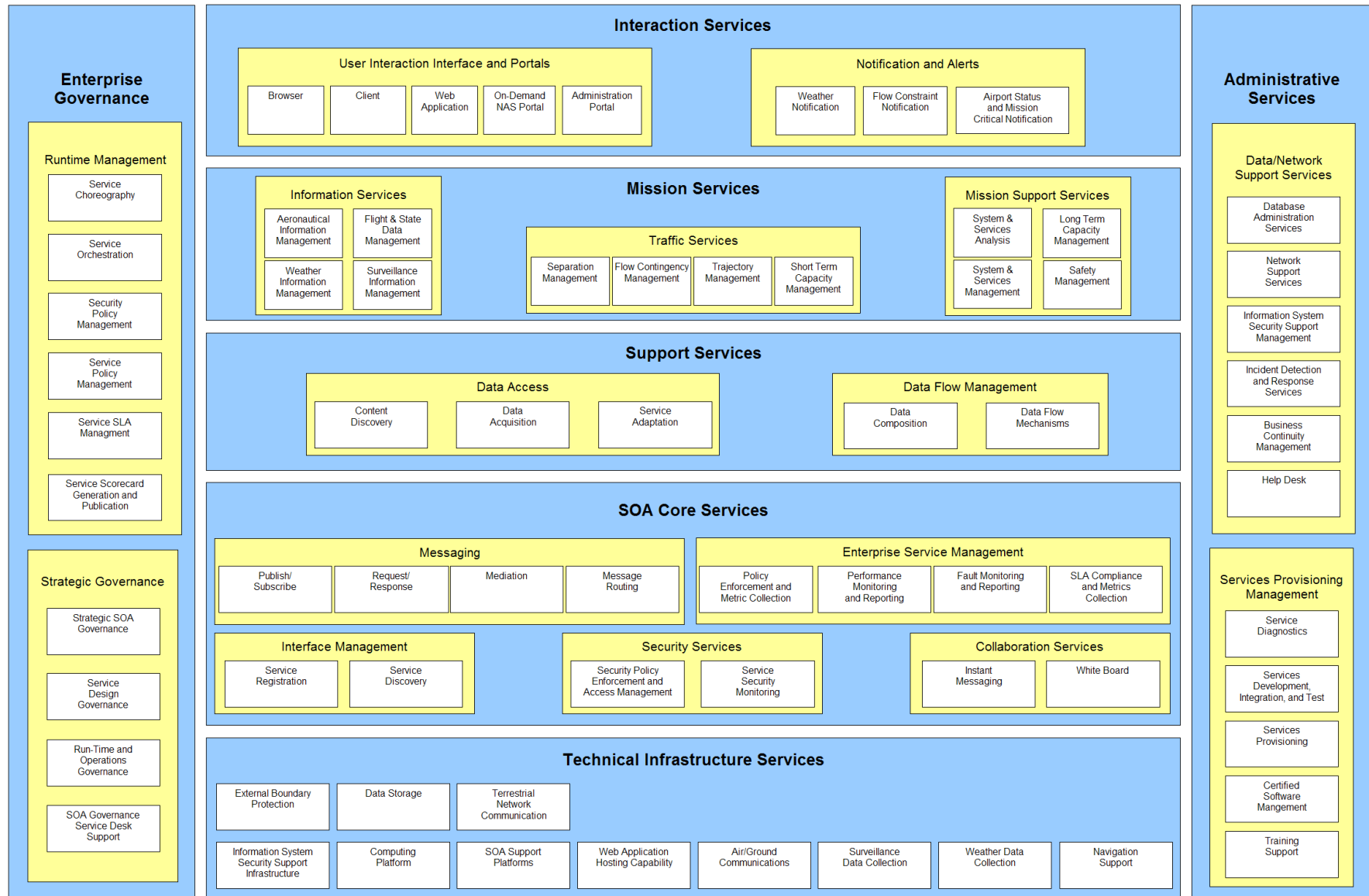
Figure 2: Far-Term SV-4 Layered Diagram

4.2 Far-Term SV-4 Mission Services Functional Hierarchy

At this time, the Far-Term SV-4 functional decomposition is focused in scope to the NAS Mission Services. The Mission Services service family includes the application services that provide mission business logic. The functions decomposed in this layer reside in NAS systems that support air traffic operations (ATO).

The Far-Term SV-4 Mission Services functional hierarchy is an exposition of the enterprise services' functions in the Mission Services from the Far-Term SV-4 Layered Diagram. The functional hierarchy contains the following elements:

- Service Category: An additional layer of categorization that defines the context of a specific capability component within a given service family.

- Enterprise Service: Capabilities that are implemented using design principles that support interoperability, sharing and the reuse of functions across the enterprise. They exist as operationally oriented processes, applications, infrastructure, or any combination.

- System/Service Function: Actions performed by services or systems to support the operational activities required by a mission or business goal to achieve a desired system objective (or stakeholder need) and reside within an automation system to transform, display (Graphical User Interface) and exchange data.

- Hierarchical Relationship Line: Depicts a parent-child association between two functions where the parent is generally displayed above the child. All child functions represent a more detailed constituent part of the parent. Additionally, all children depict the totality of the sub-actions of a parent.
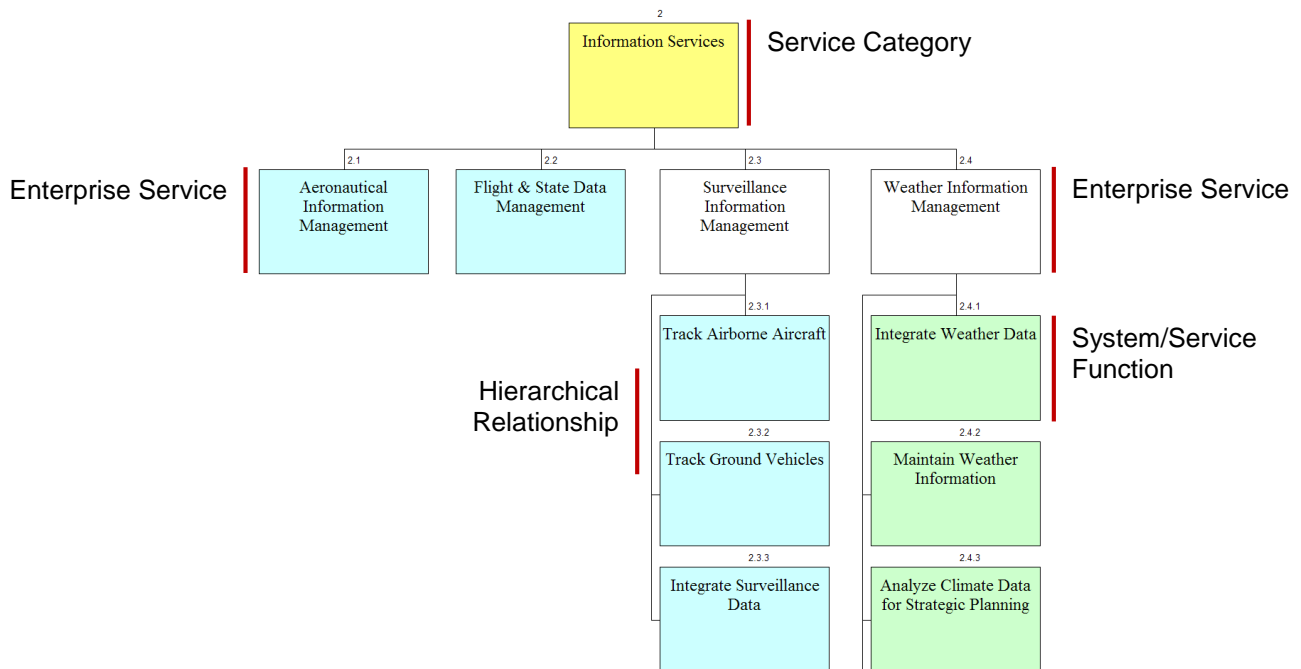

Figure 3: Notional SV-4 Functional Hierarchy

The following color scheme identifies sub-functions based on the net-centric analysis and system mapping discussed in Development Methodology:
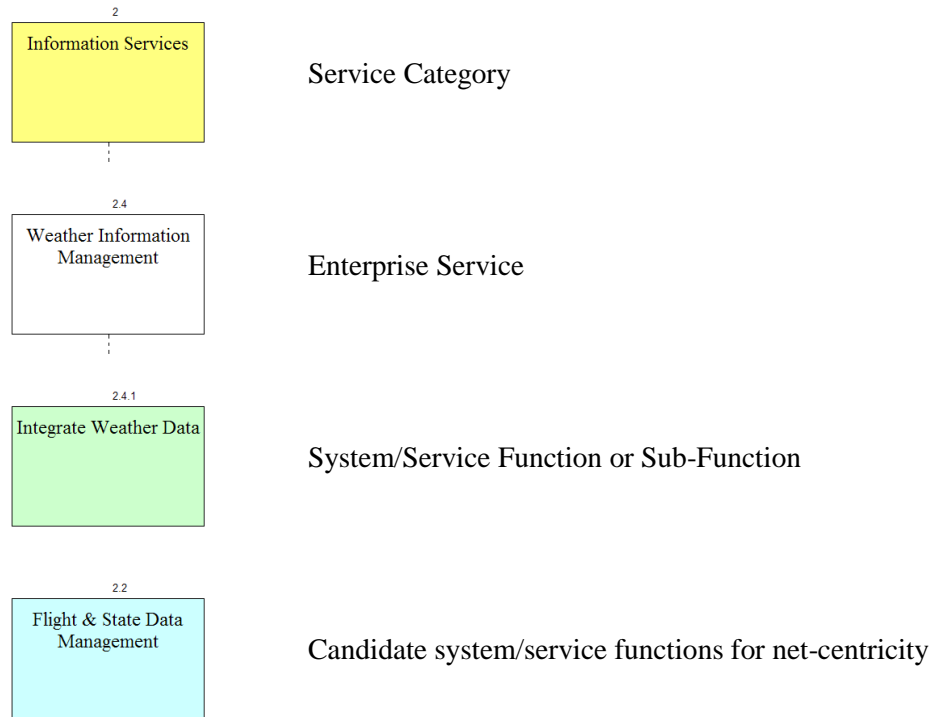

Figure 4: Legend for Far-Term SV-4 Functional Hierarchy

SV-4 H: Traffic Services

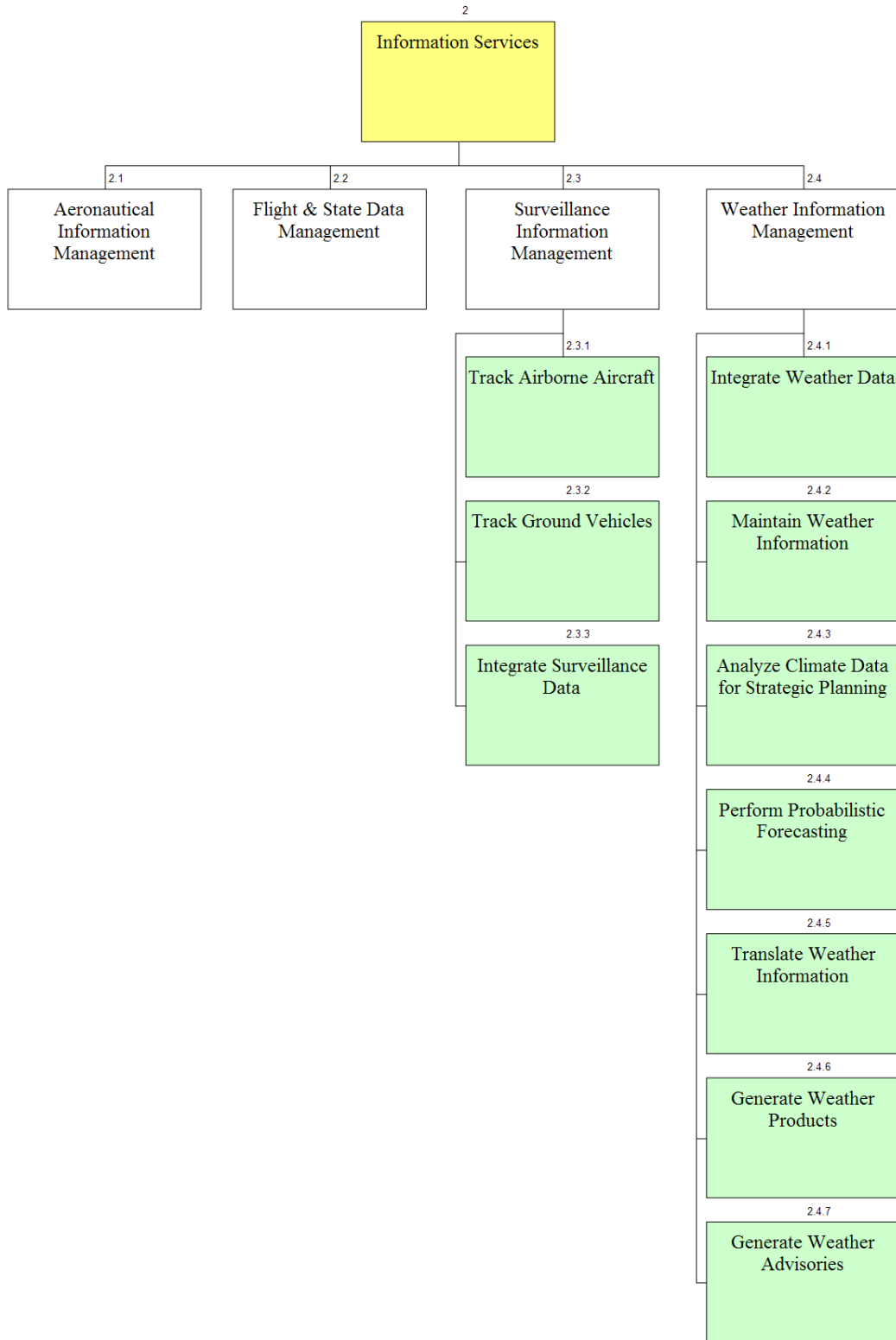**Figure 5:** Traffic Services Functional Hierarchy

SV-4 H: Information Services

Figure 6: Information Services Functional Hierarchy
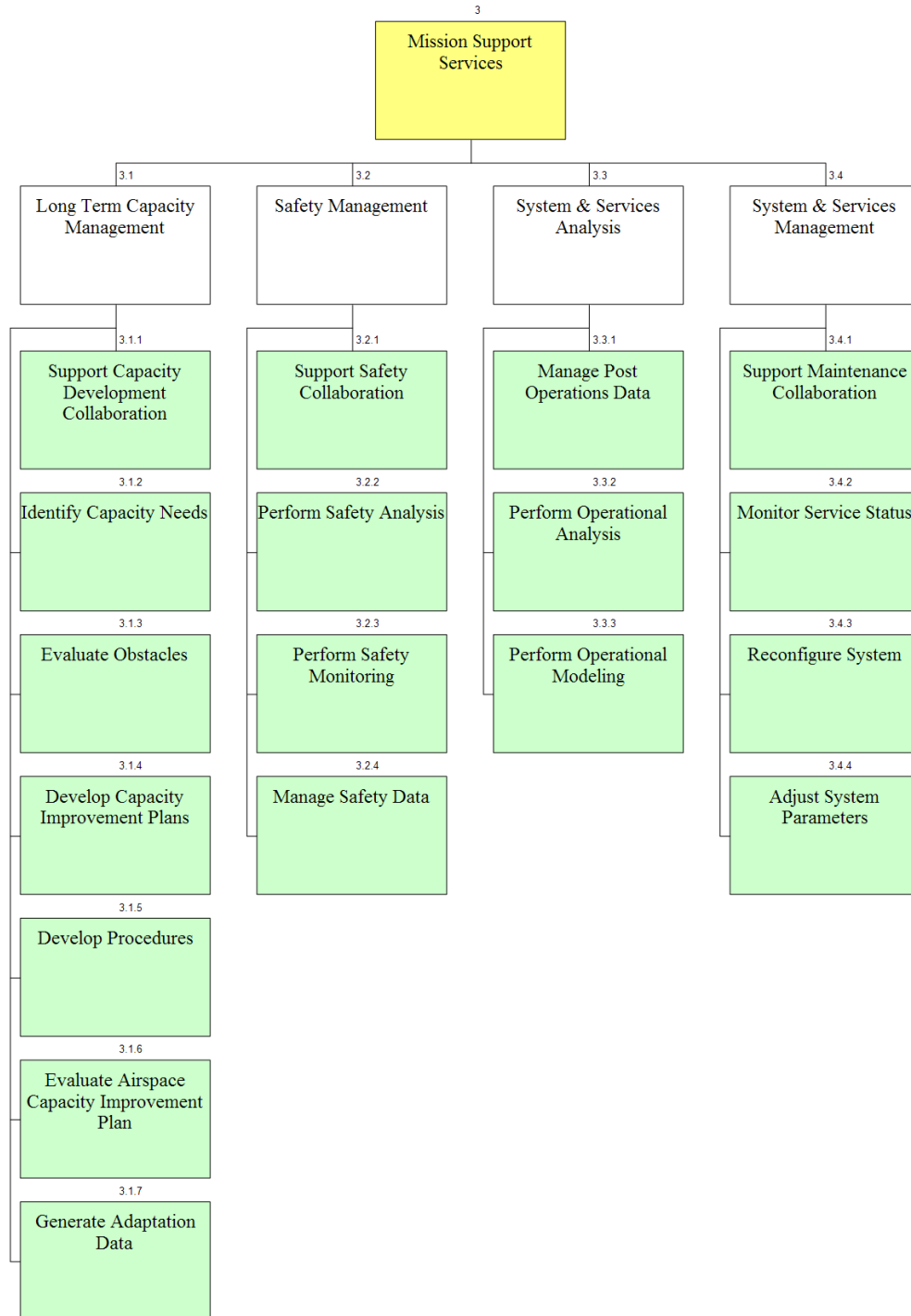
SV-4 H: Mission Support Services

Figure 7: Mission Support Services Functional Hierarchy

4.3 Far-Term SV-4 Technical Infrastructure Services Functional Hierarchy

While a full analysis has not been performed for all the enterprise services within the Technical Infrastructure Services service family, the following enterprise services have functional decompositions: Surveillance Data Collection, Weather Data Collection, and Navigation Support. These enterprise services used to reside within the Mission Services, but were relocated to the Technical Infrastructure Services after a better understanding of their functional behavior. The same hierarchical elements and coloring-scheme identified used in the Mission Services functional hierarchy also applies to the Technical Infrastructure Services functional hierarchy.

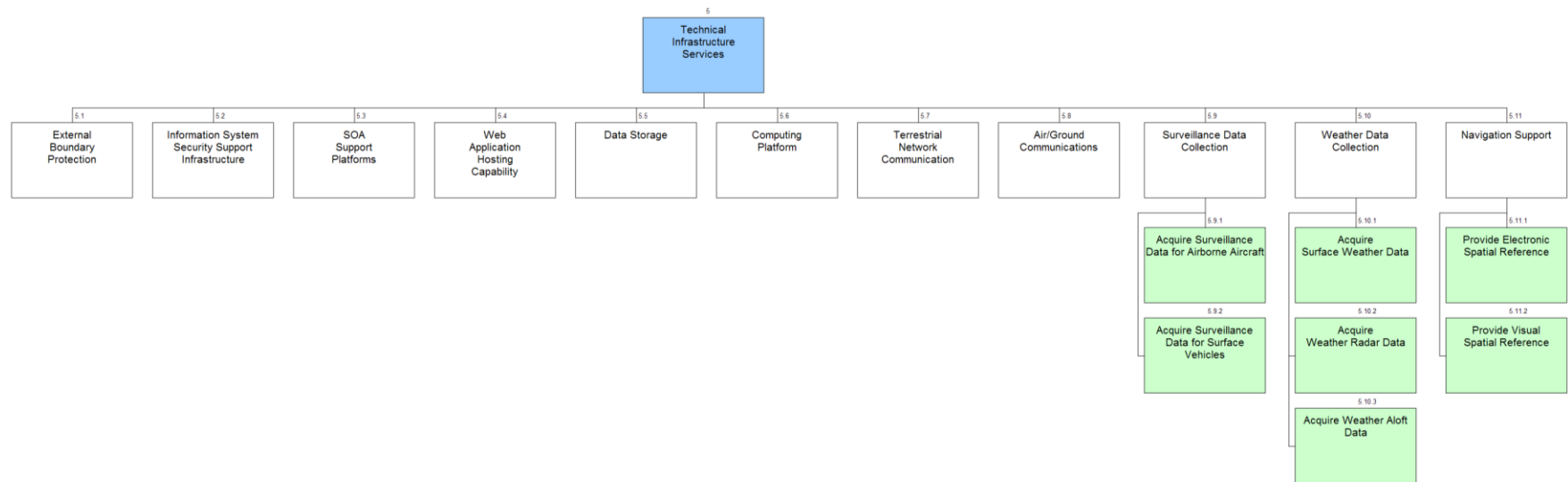# SV-4 H: Technical Infrastructure Services

Figure 8: Technical Infrastructure Services Functional Hierarchy

Appendix A: Acronyms

ANG	Directorate of NextGen and Operations Planning
AV	All View
FAA	Federal Aviation Administration
FT	Far-Term
ISEF	NAS Integrated Systems Engineering Framework
MT	Mid-Term
NAS	National Airspace System
NAS EA	National Airspace System Enterprise Architecture
NextGen	Next Generation Air Transportation System
OSI	Open Systems Interconnection
OV	Operational View
SV	System View